NRCS Hydro

ArcView GIS Interface to WinTR-20

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Introduction

The NRCS Hydro system may be used to develop input for the WinTR-20 hydrologic model from Geospatial Information System (GIS) data. Required GIS layers which need to be developed by the user for import to the interface include Digital Elevation Model (DEM), soil data, and land use. A stream layer such as National Hydrograph Dataset (NHD) is optional but recommended. The user may also import any other layers which would be useful in identifying locations, roads, streams, etc. Some of these optional layers include TIGER data, Hydrologic Unit Code (HUC) maps, etc.

In addition, NRCS Hydro will execute the WinTR-20 program with the basic data derived from GIS and a small amount of actual user input. The output file is opened in a window for viewing. Further refining or use of advanced WinTR-20 options may then be accomplished through the use of the WinTR-20 Controller/Editor. The WinTR-20 system has a comprehensive User Guide, a Quick User Guide, training material, example data, and other technical documentation.

NRCS Hydro is based on the GISHydro2000 system developed at the University of Maryland which is designed to be used only in Maryland. Certain extensions, computational modules, and menu options which are part of GISHydro2000 are utilized by NRCS Hydro. The GISHydro2000 system contains both required and optional GIS data layers and databases which cover the entire state of Maryland and parts of neighboring states. NRCS Hydro is designed for use in any watershed where required GIS data (DEM, land use, and soil) are available. Even though the system is point-and-click, basic familiarity with GIS terminology and hydrologic principles are recommended.

System Requirements

NRCS Hydro requires the following minimum operating system and hardware configuration:

Windows NT 4.0, Windows 95 or more recent
Intel Pentium or compatible processor, 100 Mhz or greater
Video display resolution of 600 x 800
250 MB hard disk space, and CD-ROM drive

Software Requirements

NRCS Hydro is based upon the ArcView GIS program from ESRI (Environmental Systems Research Institute). The following software requirements are necessary to operate NRCS Hydro:

ArcView GIS Version 3.2 or more recent
ArcView Spatial Analyst Extension version 1.1 or more recent
NRCS Hydro ArcView project and databases (copied from CD to computer hard drive)

NRCS Storm Data

Two ACCESS database files which contain a list of states and counties with their rainfall frequencies are included with the system. They are: states.dbf (file which has states listed for the NRCS storm data) and TR20_Rain.txt (file which has storm rainfall data from 2-year to 100-year by state and county).

Hydraulic Geometry Coefficients

Since the standard 30 meter resolution DEM does not allow for accurate definition of channel width and depth for small watersheds, hydraulic geometry coefficients which relate channel depth and width to the drainage area are used. The user may develop these through field measurements, use coefficients already developed for a geomorphic region, or use the default values (coefficients for the Eastern U.S.).

DEM Data

A Data Preparation Guide has been prepared with detailed instructions for obtaining the GIS data and organizing it for use in NRCS Hydro. A GIS DEM layer is required for the general area being studied. One good source is the NRCS Lighthouse Data Gateway. If the watershed spans several U.S. Geological Survey quads, it is recommended to download a National Elevation Dataset (NED) 1 degree latitude by 1 degree longitude DEM. The standard cell size is 30 meters which converts to 98.425 feet.

Digital Land Use Data

A GIS land use layer is required for the general area being studied. One good source is the NRCS Geospatial Data Gateway. Three text files are included with the NRCS Hydro system which represent runoff curve numbers for the standard USGS land use categories. These represent good, fair, and poor hydrologic condition as defined in NRCS hydrologic references such as WinTR-55. If another GIS land use layer is being utilized, the three text files may be used as models to edit and adapt to the land use categories and conditions of the watershed. The files contain the land use code, land use name, and then the runoff curve number that applies to that land use on Hydrologic Soil Groups A, B, C, and D.

Digital Soil Data

SSURGO (detailed) or STATSGO (general) digital soil data may be used. The primary soil attribute used in NRCS Hydro is the hydrologic soil group (A, B, C, or D). After the soil GIS layer is obtained, a data layer for hydrologic soil group needs to be created.

Software Features and Operation

NRCS Hydro is organized to automate the process used in a typical watershed hydrologic analysis. Its functionality is grouped into a series of menus, buttons, and tools which are designed to be used in a sequential manner. In conducting a watershed hydrologic analysis, the following simple procedure is generally followed.

1. Locate the design point based on stream/road crossing.
2. Determine the extent of the watershed draining to the outlet point. Delineate the watershed boundary.
3. Subdivide the watershed into sub-areas based on watershed heterogeneity and locations where peak discharges and/or hydrographs are desired within the watershed.
4. Obtain rainfall frequency data. Select method for calculating the Time of Concentration (NRCS Lag Equation or Velocity Method).
5. Enter channel depth and width coefficients.
6. Estimate hydrologic parameters such as area, runoff curve number, and time of concentration for each sub-area.
7. Estimate length and cross section rating tables for channel routing reaches.
8. Assemble model input and develop WinTR-20 model schematic.
9. Format model input for WinTR-20, execute the model, and view results.

To the greatest extent possible, steps in this procedure have been automated by taking advantage of geographic data, hydrologic data, and GIS processing capabilities. The sections that follow describe tools used to perform the analysis procedure described above.

Watershed Tool 

The Watershed Tool is used to delineate the watershed draining to a user-defined outlet point. It is necessary that the outlet be placed directly on the raster channel network. The watershed may be divided into sub-areas using the Add Streams and Add Outlets Tools.

Add Streams Tool 

Use the Add Streams Tool to select which streams will be used to define the WinTR-20 model stream network. Select the tool from the toolbar and click on the upstream raster of the stream. An unlimited number of streams may be added using this tool.

Add Outlets Tool 

Use the Add Outlets Tool to indicate additional sub-area outlet points on the channel network. Select the tool from the toolbar and click on the desired point along the raster channel network. By default, outlets are designated at confluence points along the channel network. Use the Add Outlets Tool to select intermediate or in-line subdivision points.

Add Cross Section Tool 

Use the Add Cross Section Tool to indicate cross section transect lines for stream segments to be used as channel routing reaches. Click on the Add Cross Sections tool and draw a transect line perpendicular to a stream segment. The Cross Section Editor dialog box will contain data developed from the DEM, a cross section rating table, and default values upon which the rating table is based. The user may revise the slope, channel width, channel depth, and Manning n if these values do not represent the characteristics of the location. The cross section rating table includes a relationship of elevation, discharge, flow area, top width, and slope for that transect location. A plot of the cross section transect developed from the DEM may be viewed by clicking the Plot button. If a cross section is not satisfactory, it may be re-drawn at another location.

Control Panel

The Control Panel dialog box allows the user to select an input and output file name and various input and output options. The Antecedent Runoff Condition (ARC) may be selected at condition 1 (dry), 2 (normal), or 3 (wet) prior to the storm. If the user Loads NRCS Storm Data, the design storm type is placed in the Design Storm Type data box. If the Load NRCS Storm Data option was selected earlier, the 24-hour rainfall frequency data should appear in the rainfall data box (otherwise default rainfall values appear). These may be edited. The user may then select storm events for which simulations are desired.

Execute WinTR-20

A menu selection allows the user to execute WinTR-20 which will open the output file for evaluation. If there are errors, the error file is opened. For most errors encountered so far in testing, the user may go back and revise certain steps, then re-run WinTR-20 successfully. Upon successful completion of NRCS Hydro, further refining or use of advanced WinTR-20 options may then be accomplished by importing the input file into the WinTR-20 Controller/Editor. Options currently not included in the NRCS Hydro system are: a) use of an alternative dimensionless unit hydrograph, b) use of an alternative rainfall distribution table, c) reservoirs for flood control evaluations, and d) import of HEC-RAS cross section rating tables for reach routing (these functions are available through use of the WinTR-20 Controller/Editor). It is available from **www.wcc.nrcs.usda.gov/hydro/.**

Introduction to NRCS Hydro
Using ArcView
Date: July 7–9, 2004
NRCS NCGC Training Room
Fort Worth, TX

Wednesday, July 7

8:00 – 8:15 **Introduction**

8:15 – 9:00 **Lecture 1:** General Processes: Overview of hydrologic modeling and GIS, general steps in completing a hydrologic analysis.

9:00 – 9:30 **Lecture 2:** Install NRCS Hydro on Computers: Directory structure, location of important files.

9:30 – 9:45 **Break**

9:45 – 11:30 **Lecture 3 and Workshop #1:** Introduction to ArcView: Terminology, tools, and operations used in NRCS Hydro, exercises in use of tools and operations.

11:30 – 12:30 **Lunch**

12:30 – 1:00 **Workshop #1:** Introduction to ArcView: (continued)

1:00 – 1:45 **Demonstration of NRCS Hydro Application:** How to Develop a Hydrologic Model: Start a project, add themes, delineate a watershed, divide a watershed into sub-areas, run WinTR-20 and view output.

1:45 – 2:00 **Break**

2:00 – 2:45 **Lecture 4:** GIS Data: Obtaining and Preparing GIS Data: Digital elevation, land use, soil, stream, TIGER data.

2:45 – 3:30 **Lecture 5:** Hydrologic Data: Runoff Curve Number tables, channel hydraulic geometry, rainfall data, Time of Concentration, Cross Sections.

3:30 – 3:45 **Break**

3:45 – 5:00 **Workshop #2:** Complete an Application of NRCS Hydro on a Watershed: Add prepared DEM, land use, soil, etc., select a watershed, follow processing steps to complete the WinTR-20 process, view output.

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Thursday, July 8

8:00 – 8:15 **Review: Workshop #2:**

8:15 – 9:15 **Lecture 6:** Technical Aspects of Processing GIS Data: Assumptions and techniques used in NRCS Hydro to process DEM, burn streams, delineate watershed, delineate sub-areas, etc.

9:15 – 9:30 **Break**

9:30 – 10:00 **Lecture 7 and Demonstration:** Advanced Features of NRCS Hydro: Merge sub-areas; use different Tc parameters for sub-areas.

10:00 – 11:15 **Workshop #3**: Example with Intermediate Complexity: Merge sub-areas; use different Tc parameters for sub-areas.

11:15 – 11:30 **Review: Workshop #3**

11:30 – 12:30 **Lunch**

12:30 – 1:30 **Lecture 8:** Errors and How to Correct Them.

Two sessions offered from 1:30 to 2:45

1:30 – 2:45 **Lecture 9A:** Preparing GIS Data for NRCS Hydro Using ArcGIS and ArcView: Re-project, cut themes, merge shape files, merge grids, etc.

1:30 – 2:45 **Lecture 9B:** Technical Aspects of Hydrology and Hydraulics in NRCS Hydro: Assumptions and techniques used in NRCS Hydro to compute time of concentration, cross section rating table, etc.

2:45 – 3:00 **Break**

3:00 – 4:15 **Workshop #4:** Complex Example: All students start with the same watershed outlet and work independently from there.

4:15 – 4:30 **Review: Workshop #4**

4:30 – 5:00 **Lecture 10:** Post Processing: Saving information for documentation, map layout techniques, file management.

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Friday, July 9

8:00 – 9:30 **Lecture 11:** WinTR-20 Controller/Editor: Build a simple data set, view graphics output, advanced features in Controller/Editor not included in NRCS Hydro.

9:30 – 9:45 **Break**

9:45 – 10:30 **Workshop #6:** Set up and Run WinTR-20 for a Small Watershed: Input data and execute WinTR-20; view tabular and graphics output.

10:30 – 11:15 **Workshop #7:** Import WinTR-20 Data Prepared Using NRCS Hydro: Execute WinTR-20 and view graphics output, modify rain table, add reservoir, set up alternative, etc.

11:15 – 11:30 **Review: Workshop #7**

11:30 – 12:00 **Class Review/Questions and Answers**

12:00 **Adjourn**